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From Small-step to Sustainable Innovation:

Can increased co-operation between SMEs and R&D-Institutions in NCE Subsea improve the degree of sustainable Innovation?

MSc in Innovation and Entrepreneurship

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Summary:

NCE Subsea (Norwegian Centre of Expertise Subsea) is an industrial cluster located in the Bergen area. Small and Medium sized Enterprises (SMEs) affiliated with NCE Subsea have a long track-record of small-step improvements mainly performed in customer/supplier relationships. An initiative from NCE Subsea has been taken to stimulate these SMEs to improve the co-operation with affiliated R&D-Institutions (Research & Development Institutions) in order to improve the degree of sustainable innovation.

It is assumed that co-operation between SMEs and R&D-Institutions can increase the level of sustainable innovation. This research project has performed a critical review of the current situation for co-operation between SMEs and R&D-Institutions in NCE Subsea and have found that there is a potential for improvement in such co-operation and hence the sustainable innovation.

The thesis identifies both the current model and the main challenges for co-operation between SMEs and R&D-Institutions in NCE Subsea. A set of measures and recommendations to improve the co-operation situation is also evaluated and argued for in the thesis. The thesis concludes that increased co-operation between SMEs and R&D-Institutions in NCE Subsea can improve the degree of sustainable innovation as such innovation would be of a disruptive character.

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"Coming together is a beginning.

Keeping together is progress.

Working together is success."

Henry Ford

Preface

This thesis concludes a 2 year Master of Science - Technology management, Innovation and Entrepreneurship study at University of Oslo and Bergen University College. The two years have been very interesting and have given me added knowledge and experience to pursue new objectives in both my professional career and my private life.

I would not have been able to complete this study without the continuous support from my wife Christine and my two lovely daughters Hanne-Agnethe and Marianne. I have deep gratitude for their support and patience.

I am also thankful to my supervisors Tom Skauge and Stig-Erik Jakobsen. Their supervision has been helpful, encouraging and inspiring with a clear and theoretically founded message. Thanks to their long experience in mentoring master thesis, I have gained substantial knowledge throughout the project.

I will also like to thank Trond Olsen and Jon Hellevang at NCE Subsea who first of all gave me the opportunity to conduct this research project and for your support throughout the project.

Last, but definitely not least “Thank you very much to” Imenco AS, Aanderaa Data Instruments AS, WiSub AS, Amitec AS, Uni Research AS and Christian Michelsen Research AS for being positive and informative during the interviews.

Glossary

CCI	Complex Combined Innovation
DUI	Doing – Using – Interaction (Experience based Innovation)
GKH	Global Knowledge Hub
HSE	Health, Safety and Environment
ICT	Information Communication Technology
IPR	Intellectual Property Rights
MMO	Maintenance Modifications and Operations
MNC	Multi National Corporate
NCE	Norwegian Centre of Expertise
NIS	National Innovation System
R&D	Research and Development
RIS	Regional Innovation System
SME	Small and Medium Sized Enterprises (0 – 100 employees)
STI	Science – Technology – Innovation (Research based Innovation).
TH	Triple Helix (Model)

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1. Introduction

NCE Subsea is a Norwegian Centre of Expertise regional cluster for the subsea-industry in the Bergen area. It was founded in 2006 and the main objectives are to strengthen innovation activity, raise international commitment, enhance capacity, improve ability to compete and stimulate value creation for the actors within NCE Subsea (NCE, 2013, Reve and Sasson, 2012).

In NCE Subsea innovations are to a high extent carried out as small-step innovations in customer/supplier relationships (Menon, 2012). Typically customers order product improvements or upgrades to which suppliers deliver. However, it is reasonable to believe that there is a potential for improvement and better solutions if R&D-Institutions are involved. NCE Subsea aims to stimulate co-operation between SMEs and R&D-institutions within the cluster to increase sustainable innovation. In order to evaluate the current situation a situation analysis will be performed to establish a basis upon which to develop this co-operation. With the right circumstances, it is reasonable to expect that this co-operation will improve the degree of sustainable innovation which creates value for the firms, industry and R&D-Institutions.

1.1 Problem definition

In NCE Subsea it is found that innovation often is conducted in customer/supplier relationships (Menon, 2012). However, this innovation is mainly incremental and most of the time small-step innovations in the form of product improvements. The problem is that such innovation tends not to be sustainable in the longer term. Often the product improvement is specified by a single customer, and it is reasonable to believe that the product to some extent becomes customer specific and thus has a low general market value. Christensen (2003) and Fagerberg et al. (2005) argue that it is challenging for a company to base its business solely on incremental innovations. Disruptive innovations are required to maintain long term sustainability (Christensen, 2003, Fagerberg et al., 2005).

Challenges for industry-R&D co-operation are discussed in section 2.3 and highlight some significant differences between the industry and R&D-Institutions. The time perspective is central as R&D-Institutions normally have a longer time-perspective and the time required to conduct research that leads to disruptive innovations. On the other hand, the SMEs report that they, in general, don't have the required resources to conduct research that leads to disruptive innovations. The SMEs are therefore more likely to maintain a product improvement strategy based on small-step innovations that fit the available resources This leads to the core of this problem definition- if co-operation between SMEs and R&D-Institutions can be increased could that be expected to increase the degree of sustainable innovation and how can this best be achieved?

This thesis aims to highlight which model of SME-R&D co-operation is currently represented in NCE Subsea, identify the main challenges for co-operation and suggest potential measures to improve the degree of sustainable innovation.

1.2 Research questions

To be able to answer how the degree of sustainable innovation from SMEs and R&D-Institutions can be improved, four research questions have been framed.

1) Which model for SME-R&D co-operation is prominent in NCE Subsea?
2) What are the main challenges for co-operation between SME and R&D in NCE Subsea?
3) How can the relationship between SMEs and R&D-Institutions be improved?
4) How can NCE Subsea avoid the negative effects of path-dependency?

The research conducted in this project aims to answer these questions and enable recommendation of possible improvement strategies of value to NCE Subsea.

1.3 Approach

This Master thesis will be divided into 4 stages:

- The construction of a theoretical framework and then operationalize this framework in the form of semi-structured interviews with selected SMBs and R&D-Institutions.
- Prepare a situation analysis for both the model and the main challenges to co-operation between SMEs and R&D-Institutions in NCE Subsea.
- Elaborate a GAP Analysis that identifies the gap between the desired and the current situation.
- Discuss possible approaches to enable the improvement of the degree of sustainable innovation for SMEs in NCE Subsea and at the same time avoid the negative effects of path dependency.

2 Theoretical framework

The theoretical framework for this thesis discusses different modes of innovation; models of interaction between industry, government and R&D-institutions; and the challenges facing industry-R&D co-operation.

2.1 Development of an industrial path

All firms and industries have to maintain sustainable growth and value creation to secure good conditions for continuing operation. The development of an industrial path requires knowledge about how different types of businesses manage knowledge and utilize this in innovation. The following sub-section will discuss these elements.

Knowledge bases and models of innovation

> "Innovation is not a new phenomenon. Arguably, it is as old as mankind itself. There seems to be something inherently "human" about the tendency to think about new and better ways of doing things and try them out in practice." (Fagerberg et al., 2005, p. 1)

This apparent "human" tendency has led to a more technology intense industry and innovation has become crucial to all technology-driven businesses in order to maintain sustainability and value creation. Industry has, over the last decades moved from standardized production to a higher degree of specialization which in turn requires the firms to be innovative in both products and processes to meet the competition (Fagerberg et al., 2005, Spilling, 2010).

Governments can facilitate innovation and the Norwegian Government's industrial policy aims to facilitate value creation in the Norwegian economy (Regjeringen, 2012). The Norwegian government has introduced several direct and indirect incentives to stimulate innovation both at company level and system level (Spilling, 2010). One of the incentives introduced at system level is the "Norwegian Centre of Expertise" (NCE) program which will be discussed later in this chapter.

Spilling (2010), however, concludes that the Norwegian innovation policy has a weak position and one of his main arguments is that Norwegian innovation policy is based mainly on synthetic knowledge-bases and innovation based predominantly on the DUI mode. Spilling (2010) argues and recommends that a mix of both DUI and STI modes of innovation be promoted as best practice. Research conducted by Isaksen and Karlsen (2012a) concurs for small regions and recommends to upgrade existing "DUI-only firms" by recruiting human capital to the firms or related organizations, attract firms or organizations to the region or stimulate creation of new firms.

Isaksen et al. (2008) discuss three major knowledge bases; Analytic, Synthetic and Symbolic. The Symbolic knowledge base relates to cultural businesses and will not be discussed in this thesis. Analytic knowledge is of scientific character and is mainly codified. This knowledge is, in general, available to the public. Synthetic knowledge is based on experience and can be characterized as tacit, context specific and limited to certain areas, disciplines or industries. Compared to the Analytic knowledge base where knowledge transfer materializes in lectures or instructions, the synthetic knowledge transfer is often based on practical issues through trial and error.

Businesses dominated by an analytic knowledge base, utilize scientific knowledge and deductive development of models when creating new knowledge. A typical innovation model in such businesses is "Science-Technology based Innovation" (STI). STI is, in turn, characterized by scientific analysis and experiments embedded in codified knowledge. Businesses that utilize STI are often characterized by developing radical innovations and a global knowledge flow mainly between R&D-institutions (Isaksen et al., 2008, Isaksen and Karlsen, 2012b, Spilling, 2010).

A synthetic knowledge base is often found in businesses that combine both problem-solving and recognized knowledge when developing new knowledge. This is also known as inductive knowledge development and the typical innovation mode in these businesses is "Doing-Using-Interaction" (DUI), which is founded to a large extent on experience based and tacit knowledge. Innovation in these businesses often takes the form of incremental changes and enhancements to existing products or processes (Isaksen et al., 2008, Isaksen and Karlsen, 2012b, Spilling, 2010). Characteristics of STI and DUI modes of innovation are summarized in Table 1.

	STI	DUI
Knowledge bases	R&D, basic or applied (analytical and synthetic) knowledge	Experience based, (synthetic) knowledge
Main type of knowledge base developed from	Research and development projects	Daily problem solving
Main method used in the process	Scientific and research methods	Methods generated from trial-and-error processes
Main external innovation partners	Universities and research institutes	Customers and suppliers, centers of real services, cf. Third Italia, (consulting and training organizations, etc.)
Possible types of innovation	Technology push/supply-driven innovation, i.e. radical innovation	Market/demand - driven innovation, i.e. incremental innovation.

Table 1 - Characteristics of the STI and DUI modes of innovation. (Isaksen and Karlsen, 2012b, p. 119)

Isaksen and Karlsen (2012b) discuss a third mode of innovation, "Complex Combined Innovation" (CCI). CCI combines innovation modes based on experience (DUI) and research (STI). This mode of innovation requires a high extent of absorptive capacity and dynamic capability within the firms. This mode of innovation is supported by Spilling (2010) as it handles the combination of both synthetic and analytic knowledge bases. Table 2 summarizes the different modes of innovation.

		Experience based knowledge	
		Yes	No
R&D Based knowledge	Yes	CCI	STI
	No	DUI	X (no innovation)

Table 2 - Characteristics of different modes of innovation (Isaksen and Karlsen, 2012b, p. 121)

NCE Subsea

The subsea industry cluster in Hordaland County (Norway) was awarded NCE Status (Norwegian Centre of Expertise[1]) in 2006. NCE is a cluster-development program financed by Innovation Norway. NCE Subsea offers financial and technical advice, facilitates internationalisation and stimulates to collaboration between members. The main objective of NCE Subsea is support to increase the affiliated businesses' competitiveness and value creation (NCE, 2013).

A study conducted by Jakobsen and Fløysand (2010), concluded that NCE Subsea affiliated companies have both regional and external (national and international) customers. The ratio of local/regional and external/international customers varies with company size and age. Jakobsen and Fløysand (2010) found that more mature companies (established pre 2000) have a higher degree of sales outside the region than the younger companies (established post 2000). This supports the theory that a company needs to grow outside the region to maintain its sustainability (Porter, 2000, Reve and Sasson, 2012).

NCE Subsea has more than 100 affiliated businesses (NCE, 2013). The affiliates get access to the network, counselling, the opportunity to apply for financial support and access to internal information, meetings and conferences.

For NCE Subsea members, the main partners for innovation are customers and vendors (Jakobsen and Fløysand, 2010). This supports Spilling (2010) who concludes that the majority of innovation conducted in Norwegian firms is DUI based. As discussed earlier, DUI mode innovation is based on experience based and tacit knowledge. It is incremental and mainly based on market/customer's needs and designates the firms as drivers for innovation (Spilling, 2010).

Path dependence is according to Martin and Sunley (2006), a process or system that is unable to shake free from its history. A path dependent process or system can result in a negative lock-in.

" 'Lock-in' is a property of dynamic systems that arises when sequential patterns of activity form a "groove" from which it subsequently becomes difficult to deviate" (Setterfield 1997, referenced in Martin and Sunley, 2006, p. 11).

[1] http://ekstranett.innovasjonnorge.no/templates/Page_Meta____56195.aspx

Being a regional industry specific cluster, NCE Subsea must consider potential negative lock-in due to the participating industrial enterprises currently focusing on incremental innovations. A possible counter measure is to follow recommendations from Spilling (2010) and combine both DUI and STI mode innovation. This might lead to a more economically viable path development.

Path Development

Path Dependency does not necessarily lead to lock-in. Martin (2010) argues that emerging new local industries after all may not be caused only by chance or historical accident. These industries might be enabled or stimulated by pre-existing resources such as competency, skills and experience, inherited from previous paths and patterns of economic development.

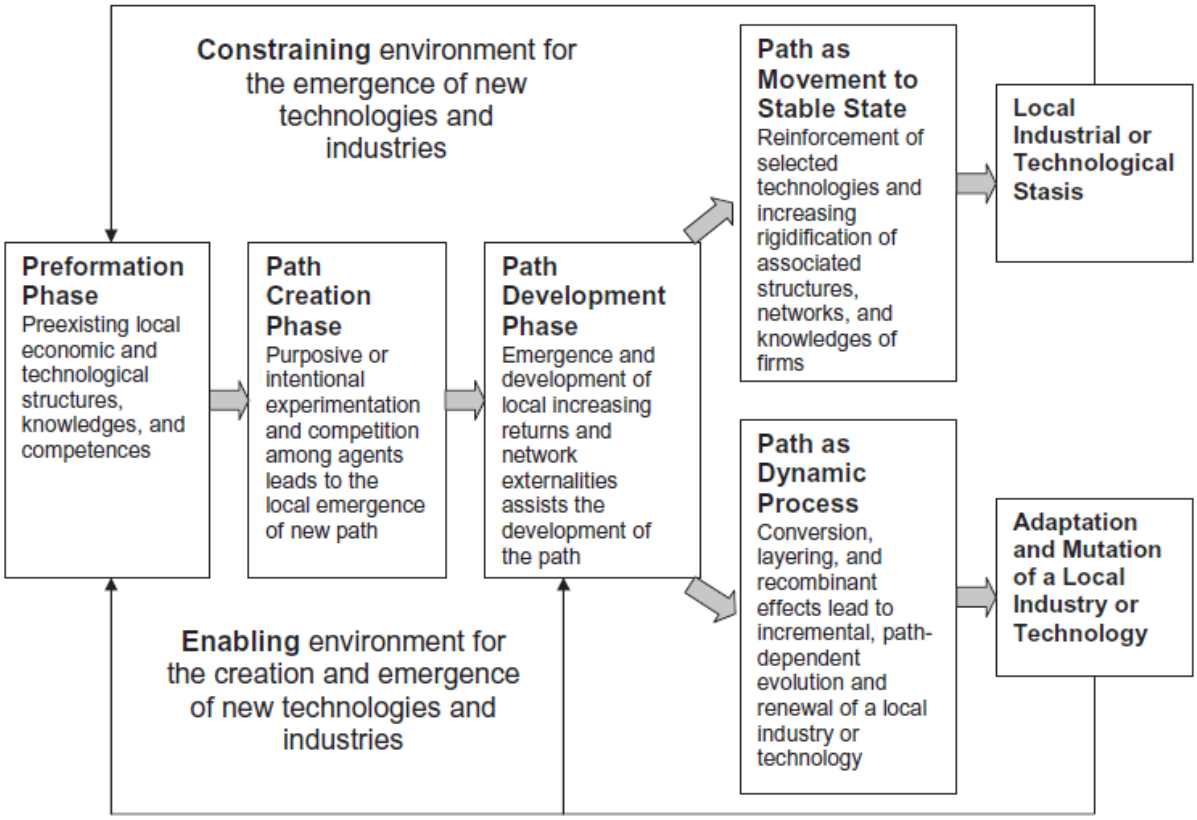

Figure 1 - Toward an alternative path dependence model of local industrial evolution (Martin, 2010, p. 21)

Figure 1 shows that it is perfectly possible for a path to develop into either a stable state or a dynamic process. With this illustration Martin (2010) shows that a path can develop into a dynamic process, the driver being industry or technology renewal resulting in dynamic positive development of a local industry or technology.

2.2 Models for Industry – R&D co-operation

The Cluster Model

The "Cluster Model" represents a system that is geographically concentrated, and consists of interconnected companies which operate within a particular field where the different affiliates both co-operate and compete (Porter, 2000). Porter (2000) argues that innovation and creation of new business is essential for any company's ability to maintain value creation and growth. Reve and Sasson (2012) argue that the main purpose for the cluster affiliates is to share common resources, knowledge and experience. The affiliated companies will co-operate in certain situations whereas in other situations they appear as competitors. Internal rivalry can improve the overall quality of products or services delivered. To summarize, the co-operation between cluster affiliates can lead to better utilization of resources, reduced cost on purchases and complementarity which in turn leads to added value for the stakeholders (Porter, 2000, Reve and Sasson, 2012).

According to Reve and Sasson (2012) a cluster's ability to be innovative is a result of the affiliated companies interaction serving global customers and also being exposed to an intense rivalry. On the other hand, a cluster that works mainly to serve local customers and is also being shielded from competition, runs the risk of losing the ability to change.

From Industrial Clusters to Global knowledge hubs

Reve and Sasson (2012) argue that attractive Norwegian industrial clusters need to become more knowledge-based and globally focused because of a high-cost structure. An example of a "Global Knowledge Hub" is illustrated in Figure 2 where the core, and central elements of the hub, is R&D institutions, educational institutions and innovation. Externally there are 4 main challenges to overcome if the Hub is to be successful. The Hub has to be globally attractive to talent as well

as technology and the industries within it must be able to meet both economic and environmental challenges.

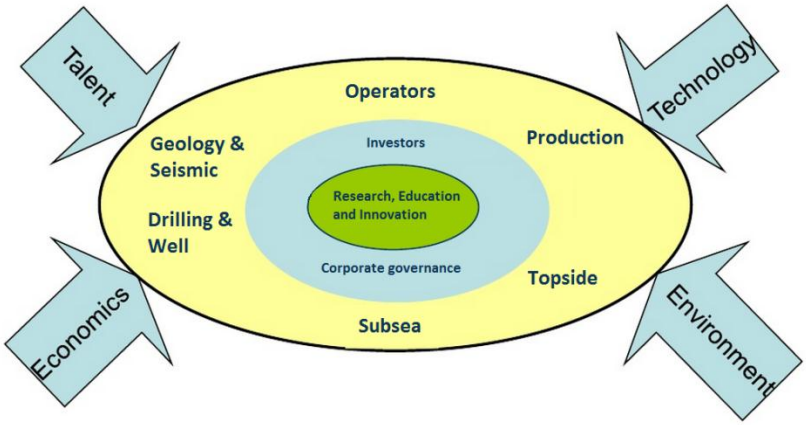

Figure 2 - The Norwegian Off-shore Industry as a Global Knowledge Hub (Reve and Sasson, 2012, p. 40)

There are several Global Knowledge Hubs recognized world-wide. Houston, Silicon Valley and Boston have Hubs second to none within Oil & Gas, Information Technology and Bio-tech. In Norway we fund several specialized international industry clusters such as Offshore Drilling (Kristiansand), Systems Engineering (Kongsberg) and Subsea Technology (Bergen) (Reve and Sasson, 2012).

The Cluster model – summary

Industrial clusters have been a part of the economy for decades. However, many clusters have changed from being local industries and economies to becoming a major part of the global industry and global economy. The main characteristics for a cluster are that it is geographically concentrated, industry specific and driven by the industry's needs. The focus for the cluster is its Industrial partners. The sustainability and value creation of the cluster rests upon innovative businesses, complementarity and competition. R&D-institutions are important partners within the cluster along with universities and other educational institutions.

Depending on the objectives for affiliated R&D-Institutions it might be sufficient for these institutions to be focussed only on the needs of local industry. However, it is reasonable to believe that there will be situations where the affiliated R&D-Institutions have other specific objectives,

not necessarily immediately related to the cluster's activity; such a model might not be optimum for the R&D-Institutions.

The RIS Model - Regional Innovation Systems

A "Regional Innovation System" (RIS) is an institutional infrastructure which aims to support innovation within a region (Asheim and Isaksen, 1997). The RIS concept is relatively new. It first appeared in the early 1990s and was a result of a study conducted by C. Freeman where Japan's economy was analysed (Asheim and Gertler, 2005, Asheim and Isaksen, 1997, Cooke, 2000). The RIS is, in many ways, inspired by the National Innovation System (NIS)[2] as a geographically demarcated innovation system. However, unlike regional industrial clusters, a RIS is not specific to any industry (Asheim and Isaksen, 1997).

An innovation system can be characterized as containing narrow or broad innovation systems (Asheim and Isaksen, 1997). The narrow innovation system includes R&D-institutions, Technology institutes and universities, whereas the broad innovation system also includes parts and aspects of the economic system such as production systems, marketing systems and financing systems. Asheim and Isaksen (1997) argue that narrow definition innovation systems have commonalities with a linear innovation model whereas broad innovation systems include elements of the interactive innovation model.

> "*the concept of region highlights an important level of governance of economic processes between national level and the level of the individual cluster or firm.*"
>
> (Asheim and Gertler, 2005, p. 299).

Cooke (2000) points out some important conditions that are essential for a RIS to be successful. These include a regional stock exchange, jurisdiction plus competence at the regional government level and a regional credit based system for co-financing. It seems positive for the RIS if the region has such conditions. In Norway a regional stock exchange exists in Oslo (and Bergen) with electronic access. In terms of regional governance, Norway is divided into 19 counties, each with

[2] NIS was examined by B-Å. Lundvall in 1988 and R. Nelson in 1993 (Asheim and Gertler, 2005, p. 299).

their own county government functions and competence. For co-financing, Norway meets some of the financing conditions through Regional Research Funds[3], Innovation Norway and the Arena-program[4].

So far so good but on the negative side, in Norway Asheim and Isaksen (1997) argue that the majority of innovations are incremental within territorial agglomerations, especially if the regional economy is dominated by clusters of SMEs. They argue that it seems doubtful that incremental innovations will be sufficient in the long run to secure value creation and sustainability. They point to the need to have innovation with:-

> "*the capability to break path dependency and change technological trajectory through radical innovations, so as to avoid falling into 'lock-in situations' as a result of 'weak competition' from low cost producers.*" (Asheim and Isaksen, 1997, p. 301)

In other words, incremental innovation alone will not be sustainable in the long run as low cost producers will be able to capture any market share with equivalent products at a lower price. Asheim and Isaksen (1997) argue that preventative measures could be to initiate long-term strategic relationships, invest in R&D and engineering skills and establish new organizational and inter-organizational models in order to avoid such "lock-in situations". Alternatively, introduction of more formal R&D-based (product and process) innovation could also upgrade the innovative capability.

The RIS Model – Summary

The RIS consists of a matrix which includes innovative businesses, R&D-institutions, educational institutions, and financial and government institutions. The RIS can be either narrow or broad based within the structure and the partnerships, but R&D-institutions, Technology institutes and Universities, always need to be present in a RIS and hence facilitate sustainable innovations.

There are many similarities between the RIS Model and the Cluster Model. However, a major difference is that the RIS-model is not necessarily industry specific and the main purpose is collaboration between the different parts of the system. Compared to the cluster model, a RIS is

[3] http://www.regionaleforskningsfond.no/prognett-rff-hovedside/RFF_in_English/1253976860326
[4] http://ekstranett.innovasjonnorge.no/templates/Page_Meta____57487.aspx

based on collaboration between the affiliated partners which at first might be more beneficial for the R&D-Institutions. However, it is reasonable to assume that a more beneficial situation for the R&D-Institutions will lead to a higher degree of sustainable innovation which in turn will benefit all included parties.

The Triple Helix Model

Unlike cluster theory and RIS/NIS, the Triple Helix (TH) model is not geographically bounded. Analysis of the Triple Helix Model show that the universities play an important innovation role in the knowledge based societies. In addition, this model differs from NIS, which considers that the businesses have the principal role in terms of innovation. In the TH Model, the R&D-institution is considered to be the driver for innovation (Etzkowitz and Leydesdorff, 2003, Leydesdorff, 2012). The TH Model envisions three parties where interaction can be represented as occurring in a helix or spiral.

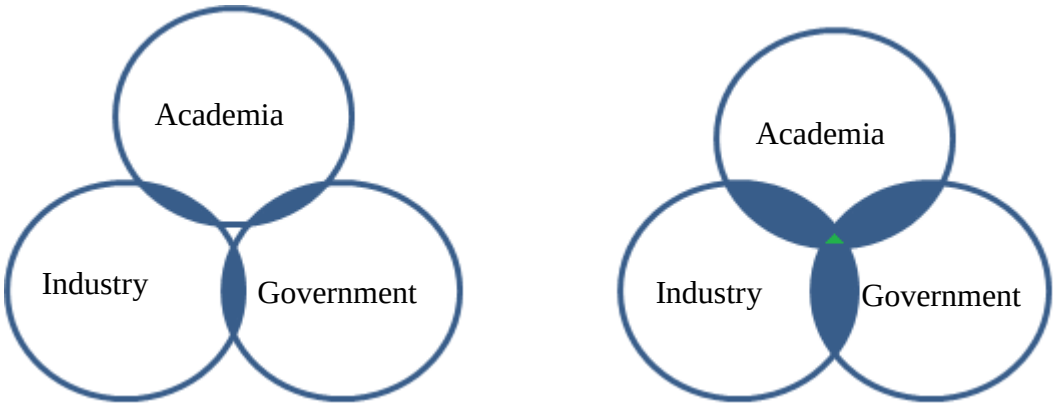

Figure 3 - Triple Helix with negative and positive overlap

Figure 3 shows two versions of the Triple Helix model[5]. The model on the left shows ”negative overlap” in which only bi-lateral co-ordination exists and overlap is present between any two of the actors but never between all three. In the model on the right both bi-lateral and tri-lateral co-ordination mechanisms are found which is termed “positive overlap”. An important consideration is that “The system remains in transition because each of the partner institutes also develops its own (differentiating) mission” (Leydesdorff, 2012, p. 3).

[5] (Leydesdorff, 2012, p. 3)

The tri-lateral model, with positive overlap, would seem to be the better model for a University-Industry-Government relationship, as it includes the common interacting relationship of all three of the university-industry-government actors as well as the internal bi-lateral exchanges between them. The bi-lateral model on the left with negative overlap shows only bi-lateral internal development within each sphere. Leydesdorff (2012) further describes four sub-dynamics of the TH model where the interaction of the actors can destabilize, hyper-stabilize, meta-stabilize or eventually globalize a relatively stable system. Globalisation can be desirable as it can change the system to prevent lock-ins and path-dependencies (Shinn 2002, referenced in Leydesdorff, 2012, p. 6) argues that "the central role of many TH studies is based on the assumption that this system is more adaptive than others because of the continuous flux of students."

Etzkowitz and Leydesdorff (2003) argue that the TH shows how universities have developed the relationship between university and industry. However, equally important, it also allows for the internal transformation within each sphere. Universities have transformed from teaching institutions to institutions that combine Research and Teaching. This combination is found to be more productive and cost effective (Etzkowitz and Leydesdorff, 2003).

Summary Triple Helix

One of the differences from TH to RIS and industry clusters is that the universities are drivers for TH co-operation. Another difference is that a TH co-operation is geographically independent. There are no pre-requisites that the involved parties need to be geographically close. A potential challenge for TH co-operation is the time perspective of the academic part of the co-operation. The academic part has a long time perspective for the co-operation, and I find it reasonable to assume that this is a potential conflict area with the other spheres where the time perspective may well be much shorter. This challenge is further discussed in section 2.3. However, the "Triple Helix model provides an incentive to search for *mismatches* between the institutional dimensions in the arrangements and the social functions performed by these arrangements." (Leydesdorff, 2012, p. 12)

Dynamics in models for Industry – R&D co-operation

Analysis of the three models for industry-R&D co-operation is summarized in Table 3 and shows that there are some common denominators for the three models. A local cluster can scale towards a global cluster, but the R&D-Institutions need to be drivers for innovation. On the other side, an Innovation system can fit perfectly to one of the three models, but the system can also be dominated by one model with elements from the other models. It is important to be aware of the difference in the different systems to be able to utilize and benefit from all three models even if a single model is prominent.

Summary Models for Industry – R&D co-operation

	The Cluster Model	The RIS Model	The TH Model
Key actors	Specialized firms	Firms R&D-Institutions	Government R&D-Institutions Firms
Drivers for innovation	Networking between specialize firms	Co-operation between different actors	R&D-Institutions
Premise makers	Firms	Firms, R&D-Institutions Government	R&D-Institutions
Premise takers	R&D-Institutions		Firms
Strategy	Specialisation (Co-operation between different parties within the same industry)	Diversification (Benefit from actors within different industries)	Variation (New role for academic institutions)
Facilitators	Cluster Facilitators	Intermediate actors	Government/Academia Intermediate actors
Scale	From local to global. (Moving towards global will require the R&D-Institutions to become premise makers and drivers for innovation)	From regional to national	From regional to global

Table 3– Summary Models for Industry – R&D Co-operation

2.3 Challenges for "Industry – R&D" co-operation

R&D-Institutions and the industry in general will in most cases have different knowledge-bases. The analytic knowledge base of R&D-Institutions and the synthetic knowledge base of an industry introduce some potential challenges for co-operation.

Engelsen et al. (2013) describe a set of challenges (summarized in Table 4) that must be taken into consideration when planning for Industry – R&D co-operation. The differing time perspective is seen as being the most challenging as the industrial partner depends on launching new innovations in the market to create value for itself. On the other hand, The R&D-Institution's objective is the research itself which creates value to the R&D-Institution (Engelsen et al., 2013).

Challenge	R&D institutions	Industry
Time perspective	Long	Short
Type of knowledge	Research-based	Experience-based
Orientation	Knowledge production	Knowledge utilization
Organizing	Closed (linear)	Open (interactive)
Network type	Formal	Informal
R&D Motivation	Exploration	Exploitation

Table 4 - Challenges for "Industry–R&D" co-operation

3 Methodology

The problem definition, research questions and constraints for this thesis has led to the methodology defined in this chapter. The research design, selection of cases, methodology will be discussed before reliability and validity is defended.

The original meaning of "methodology" means "the way towards the target", and it can be defined as the approach to solve a problem (Kvale et al., 2009). For research projects the researcher is responsible for acquiring necessary knowledge (Mehmetoglu, 2004). Mehmetoglu (2004) list the two main approaches to acquiring knowledge for social science research as being the "qualitative" and "quantitative" methods.

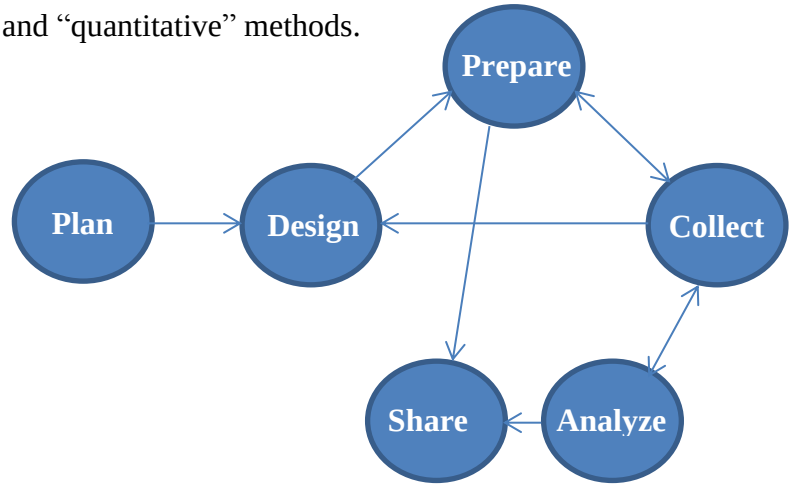

Figure 4 - The Case Study Research Process (Yin, 2012, p. 1)

Yin (2012) describes the "Case Study Research Process" as a linear but iterative process, displayed in Figure 4. The first step in the process is planning. During this phase, the research questions are defined, case study method decided and an understanding of strengths and weaknesses established. The Case Study Research method is used in many situations, but the objective is to contribute to our knowledge of individual, group, organizational, social, political and related phenomena. It is a commonly used research method in areas like psychology, social science, business and education. Case studies within these areas gives the researcher meaningful characteristics of real-life phenomenon (Yin, 2012).

3.1 Research design

Research design is the researcher's way of organizing research activities which includes collection and analysis of data in a way that most likely will achieve the aims for the study (Easterby-Smith et al., 2012, Ringdal, 2013). For this research, due to the time constraint, a case study with qualitative interviews was selected as the most appropriate approach. This chapter will describe the process and the different methods and decisions which forms a basis for the research.

Problem definition and research questions

The purpose of a problem definition is to establish a research basis and depending on how much information already exists; the problem definition can be wide or narrow (Everett and Furseth, 2012). A problem that is well explored will more often result in a detailed and specific problem definition compared to a problem that is relatively unexplored. The research questions are derived from the problem definition and their purpose is to enable the researcher to find solutions to the problem. A thorough definition of the problem with specific research question will provide a good base for the research. (Everett and Furseth, 2012).

The problem definition and research questions for this thesis are discussed in section 1.1.

3.2 Chosen methodology

To answer the research questions identified in this research project the chosen methodology is a qualitative case-study research based on semi-structured interviews and literature search. This method was primarily chosen because of the time constraint; approximately 4 ½ months from January to May. A quantitative research project was assumed not to meet the time constraint and was therefore rejected.

During the first phase of this research project, public available literature in the form of reports and web-pages were collected and considered. The theoretical framework was created and operationalization developed as two semi-structured interview guides that were used as a basis for the conducted interviews. One guide was prepared for the SMEs and one guide was prepared for the R&D-Institutions. See appendixes A in section 7.1 and B in section 7.2.

Case study research method

Case study "is a way of investigating an empirical topic by following a set of predefined procedures" (Yin, 2012, p. 21). Yin (2012) discuss several research methods and recommends case study where the focus is on contemporary events rather than behavioural events. Research questions for such a case study are formed as "How" and "Why", this fits nicely with the study defined in this project.

> "*The essence of a case study, the central tendency among all types of case study, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result.*" (Schramm 1971, referenced in Yin, 2012, p. 17)

Qualitative research interview

A qualitative research interview aims to understand the world from the respondent's side. It strives to reveal the respondents experience and must be carefully constructed and carried out to reduce the risk of influence from the researcher (Easterby-Smith et al., 2012, Kvale et al., 2009).

It is recommended that the researcher possesses a set of skills in order to interpret the information given by the respondent as correctly as possible. McClelland, 1965, referenced in (Easterby-Smith et al., 2012, p. 128) conducted studies about "common sense notions". McClelland's conclusion was that people cannot be trusted to say exactly what their motives are. A risk is that the respondent is vague in his response which leads to misinterpretation by the researcher (Easterby-Smith et al., 2012).

"Laddering" is a technique described as getting more out of one question. Easterby-Smith et al. (2012) argues that employing the laddering technique will help the respondent to move from facts or statements to descriptive explanations in such a way that they will reveal the individual's value base. Questions that can be used for laddering are: "Why is this?" and "Why is this important for you?"

Avoiding bias is essential. The researcher is required to appear as neutral as possible to avoid influence on the respondent. This can be challenging for the researcher when designing and conducting the interview. The researcher might have a predetermined opinion of what the response to a question will be, but must remain neutral to facilitate un-biased response (Easterby-Smith et al., 2012)

3.3 Case selection

During the selection phase, it became clear that both SMEs and R&D-Institutions should be interviewed. In January 2013, there were 73 SMEs in NCE Subsea, however only 59 of these companies are engaged in either Research or Development (Subseaindex, 2013) The decision was made to sort from two criteria in order to select a representative set of respondents, the criteria being "Research intensity" and "company size". The selection was decided in co-operation with Jon Hellevang at NCE Subsea who is appointed external mentor for this project, See Figure 5 for details.

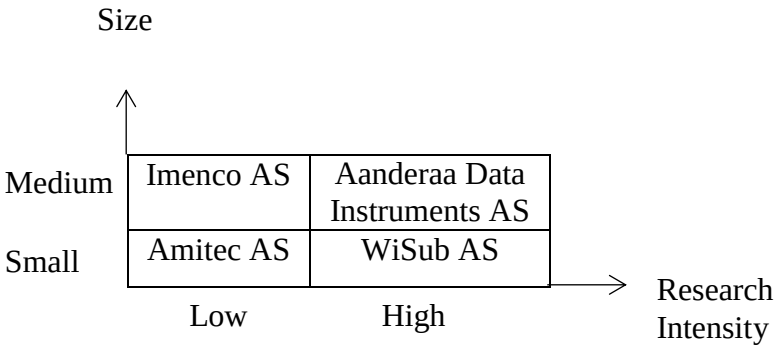

Figure 5 - The selection of SMEs

In January 2013 NCE Subsea had 8 affiliated R&D-Institutions. The majority of these R&D-Institutions conduct their research primarily in other areas which led to choosing Christian Michelsen Research AS (CMR) and Uni Research AS (Uni) which both perform extensive research within oil and gas related sciences. Uni conducts basic research whereas CMR conducts applied research, displayed in Figure 6.

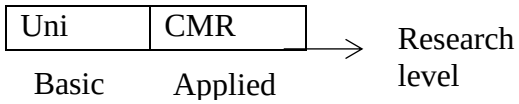

Figure 6 - The selection of R&D-Institutions

3.4 Case presentation

WiSub AS

WiSub AS was established in 2011 and the business philosophy is to mix research and applied engineering to develop disruptive innovations. The company has three employees and is located in Bergen. WiSub's main activity is based on a patent-pending technology, which they apply in the design, construction and sales of subsea connector systems for wireless high-speed data transfer (WiSub, 2013)

Amitec AS

Amitec AS is a company that focuses on industrial software related to process information management systems and Real-time Portal and collaboration solutions. The company has 13 employees and is located in Bergen (Amitec, 2013).

Imenco AS

Imenco AS' has its main office in Haugesund, south of Bergen and the company has 77 employees. The company designs and produces technical products on behalf of their customers within the oil and gas industry. Imenco AS was established in 1979 and focuses on incremental innovations and adaptations of existing products (Imenco, 2013).

Aanderaa Data Instruments AS

Anderaa Data Instruments AS (AADI) has 91 employees, with its head-quarter in Bergen. The company was founded in 1966 and acquired by Xylem Inc. in 2010. AADI operates within the fields of Marine Transportation, Oil and Gas, Aquaculture, Environmental Research and Road and Traffic Construction. The company designs and manufactures sensors, instruments and equipment for monitoring in harsh environments. (Aanderaa, 2013).

Christian Michelsen Research AS

Christian Michelsen Research AS (CMR) is a research institute conducting high quality research, development and industrial innovation related to energy, environment and space technology. CMR has its headquarters in Bergen and employs 185 people, including subsidiaries. The CMR vision is to conduct research for industrial development and it offers competence and solutions to clients through the principle "From an idea to a product" (CMR, 2013).

Uni Research AS

Uni Research AS (Uni) is a Bergen based research institution with approximately 500 employees from 50 different nations. The institution conducts research in co-operation with the University of Bergen at a high international level within health, modelling, marine molecular biology, environment, climate and social sciences (UniResearch, 2013).

3.5 Data analysis

An essential question in data analysis is: "*How can I analyse what the respondents said, in a way that enrich and elaborate the meaning of what was said*" [6] (Kvale et al., 2009, p. 200). The data analysis itself can therefore be detrimental for the research project if done incorrectly or inaccurately. Kvale et al. (2009) argue that the data analysis must be designed prior to the data collection so that it can be used as a guide in developing an interview guide, the interview process and transcription. This method ensures a data collection process which is linked to the theoretical framework.

Analyzing "*means to split something in bits or elements*" (Kvale et al., 2009, p. 201). Data analysis of semi structured interviews will therefore lead to breaking down the response into useful parts that can be used systematically in order to confirm any findings.

For the analysis of empirical data, a "Descriptive Approach" has been chosen. The descriptive approach establishes significant characteristics about an object that has been examined (Rienecker, 2012). One important property of the descriptive approach however, is that it will only describe the current status but not plan for future change or improvements. In order to be

[6] Translated from Norwegian

able to recommend how NCE Subsea can improve the degree of sustainable innovation, a GAP analysis will be performed to identify the gap between the current and the desired situation.

The decision to conduct a qualitative case study based on semi-structured interviews was made primarily to be able to finish the research project within the deadline. It might be possible that a quantitative approach would result in a more diverse response, but this would have required more resources and/or a longer time to complete and was therefore not seen as a desirable approach in this case.

3.6 Reliability – Transparency – Validity

Reliability and Transparency

The use of semi structured interviews as a method for collecting primary data has a bearing on the study's reliability. Re-creating the data will be possible, to some extent, but it requires an extensive work to re-create the same setting for both interviewer and respondent. An important aspect in order to re-create the interviews is that the interviewer's personality can play an important role in how the respondents respond to the questions. On the other side the personal aspect can be a significant benefit from semi structured interviews as the social constructivism acknowledge the linguistic behaviour (Easterby-Smith et al., 2012)

The use of an audial recorder in all interviews and openness about which cases were selected will in turn increase the study's transparency.

Validity

A study's "validity" discloses whether the collected data can be considered appropriate to answer the research questions (Easterby-Smith et al., 2012). Yin (2012) argues that using multiple sources of evidence, establish a chain of evidence and invite key informants to review the draft report will ensure a study's validity. To facilitate this study's validity, I have chosen six different cases to create a representative picture of the situation; all interviews have been recorded; transcript and the results have been discussed with some of the respondents in addition to discussing the response and interpretation with my two supervisors. The process of analysing data has thus been iterative with several recurring steps to ensure that the quality of interpretation is the best possible.

3.7 The selected case's representativeness

The selected cases were picked to give a best possible image of the current situation within NCE Subsea. During the data analysis it has become clear that some of the, previously identified desired response is absent. Plausible reasons for this are listed here.

How representative are the selected SMEs in NCE Subsea and can the selected cases be generalized?

All four SMEs are engaged in activities leading to new or improved products. It is therefore appropriate to call them innovative based on the definition of innovation discussed in Section 2.1. However, there are several SMEs, such as service providers, consulting firms and machine shops, in NCE Subsea that do not engage in product or process development. A generalisation that is applied more widely than to the innovative businesses in NCE Subsea can therefore be challenging. However, the four SMEs do seem to represent the group of innovative SMEs in NCE Subsea they do account for several different characteristics of the different firms affiliated with the cluster. The interviews were not limited to Subsea related activities, and it seems therefore reasonable to argue that the results from this research project to some extent can be generalised to similar systems for collaboration that includes both industry and R&D-institutions.

The medium sized firms studied were both in the upper range of medium sized enterprises which makes it reasonable to assume that the findings to some extent could also be applicable to larger firms with more than 100 employees.

The search for different knowledge bases in SME and R&D

In chapter 2.3, challenges for Industry-R&D co-operation were discussed. When designing this project, it was desirable to look for distinct differences in knowledge bases between SMEs and R&D-Institutions since this, to some extent, might explain why the co-operation is not optimum. However, I have not been able to find any strong indicators that this, in practice, is the situation in NCE Subsea. There are several plausible reasons for this unexpected result:

- The majority of employees in the selected SMEs are, to a large extent, people with education at Master or Bachelor level. It is therefore reasonable to believe that these

people to some extent possess an analytical knowledge base and therefore might not be significantly different from a researcher in the R&D-Institutions.

- Another plausible reason is that the employees of the SMEs are unfamiliar with the researchers at the R&D Institutions and cannot describe a particular difference.
- The third plausible reason is a tacit politeness as the SMEs and R&D-Institutions to some extent co-operate today and most likely will co-operate more in the future. If the SMEs expressed the R&D-Institutions in a negative stereotypic way, it is reasonable to believe that this could harm current or future co-operation which also can be a customer-relationship.

	WiSub AS	Aadi AS	Amitec AS	Imenco AS
Which type of background is prevailing among the engineers in the firm?	PhD and BSc, Electrical and mechanical	BSc, MSc, PhD Mechanical, physics, chemistry, mathematics, electrical and oceanography.	BSc and MSc, computer science	BSc and MSc, Mechanical

If a different set of cases had been selected to highlight a difference, it could have resulted in loss of other valuable information as it would most likely require SMEs dominated by employees at lower academic levels. The valuable information acquired is, in particular, related to challenges in R&D-projects for the SMEs.

It is still interesting to notice that responses from both R&D-Institutions indicate that the industry in general do, in fact have a stereotypic view of the R&D-Institutions. Both respondents from the R&D-Institutions state that they prior to being employed in an R&D-Institution, worked for the industry. They highlight their own experiences from Industry-R&D co-operation as follows:

"*I have a great benefit all the time I've worked for the supply industry and remember that I was very critical to the research institutes at the time. So it is quite funny to see it from the other side. You need to know the different roles.*"

Manager at R&D-Institution

"*I worked a long time for the industry and have approached the R&D-institution, I see that there is a challenge that the industry doesn't always think through how extensive it can be to conduct a Research project.*"

Manager at R&D-Institution

The search for reasons as to why the co-operation is not optimum

As stated in the problem definition, the co-operation between SMEs and R&D-Institutions in NCE Subsea is not optimum, and NCE Subsea wants to identify why this is the current status in order to initiate measures to improve the situation. For two of the interviewed SMEs, only the Managing Director was interviewed. One of these two companies was followed up with questions to a different manager who filled in with elaborated information that to some extent was unclear in the initial interview. The approach to a different manager with follow-up questions was approved by the initial respondent. This highlights the fact that some people might be biased in a situation where they answer on behalf of their company. With the follow-up questions I find it reasonable to believe that the responses acquired are representative for the current situation.

Personal interviews and practical follow up questions

As mentioned above, it was advantageous to ask some follow up questions. These questions were either asked in e-mail or by telephone as it became difficult to arrange new interviews due to limited time. This is not an ideal situation as the interviewer is not able to interpret valuable non-verbal communication. However, the vast majority of questions were asked during personal interviews and on audio record, and I am therefore confident that the follow-up questions have been interpreted in the best possible way in the current situation.

4 Analysis and Discussion

During this research project a set of research questions were constructed based on the problem definition. The background for this research project has been to identify how co-operation is currently carried out and any challenges for such co-operation between SMEs and R&D in NCE Subsea. The outcome for the research should be a critical review of the current situation and challenges for co-operation. Further the research will identify the desired situation and possible measures to increase the degree of sustainable innovation.

A table to display current and desired situation will be used as a tool for the discussion and is shown in Table 5.

Research question	Current situation	Desired situation
Which model for SME-R&D co-operation is prominent in NCE Subsea?		
What are the main challenges for co-operation between SME and R&D in NCE Subsea?		
How can the relationship between SMEs and R&D-Institutions be improved?		
How can NCE Subsea avoid the negative effects of path-dependency?		

Table 5 - Current and desired situation according to research questions

To be able to suggest possible directions to achieve the desired objectives, a "GAP analysis" will be conducted and presented. The GAP analysis is based on the current situation with respect to the discussed models for Industry-R&D co-operation and it aims to illustrate the difference between the current and the desired situation. Research questions 1 and 2 aim to identify the current situation for NCE Subsea and research questions 3 and 4 will identify how NCE Subsea can improve the current situation and possibly improve the degree of sustainable innovation.

Upon completion and analysis of the data collection, I am confident that I have been able to identify the current situation and the data has also provided some suggestions for improvements. I will first discuss the current situation for research questions 1 and 2, and then present the GAP analysis for the gap between current and desired situation. The GAP analysis will cover research questions 3 and 4.

4.1 Presentation and discussion of the results of the investigation and analysis

Research question 1 - Which model for SME-R&D co-operation is prominent in NCE Subsea?

NCE-Subsea was established as an industrial cluster in 2006. The cluster model still seems to be the current model for co-operation between SMEs and R&D-Institutions within the cluster. This is justified by co-operation that exists to a large extent on the industry's premises.

"*We have 2 projects with Polytec for development of new equipment to Statoil Kårstø.*"

Imenco

"*We're co-operating with CMR on a new CO_2-optode that we hope to commercialize soon.*"

Aadi

"*Sometimes the supplier industry sees a new field that needs research and they come to us and ask us to perform research on that. Many times that is within an area where we don't perform research. And for us to build up the required competence and research takes a lot of time and resources and if it is not within our strategic area we cannot just do that because the industry needs it. This seems to be hard for the industry to understand*."

Uni

From these statements it seems relatively evident that the SMEs act as premise maker for Industry/R&D co-operation. On the other hand, several of the respondents indicate that a major problem is lack of personnel rather than orders and that they have made a strategic decision not to focus on disruptive innovations (and hence co-operation with R&D) in order to maintain sustainability.

NCE Subsea is further an industry specific cluster that specializes within one segment of the Oil and Gas industry. The SMEs are to a large extent specialized firms and also key actors. In co-operation with the R&D-Institutions, I've found that the SMEs are the premise makers and the R&D-Institutions are premise takers. The strategy has been, and is currently, specialization within the subsea industry. NCE Subsea has appointed facilitators that manage the progress within the cluster, co-operation and more specific projects.

NCE Subsea is currently a local cluster with the majority of activity located in the Bergen region. 5 out of 6 cases are located in Bergen with the 6th located in Haugesund south of Bergen. From the total list of members and partners we find that the vast majority are located in Bergen. However, there is a strategic plan for NCE Subsea to grow outside the Bergen area. This will most likely mean more industrial partners in other locations and also new Norwegian or international R&D-Institutions.

The cluster model for industry/R&D co-operation can be scaled up to include international partners which also will benefit NCE Subsea in the moving towards becoming a Global Knowledge Hub (GKH).

	The Cluster Model	The RIS Model	The TH Model
Key actors	Specialized firms	Firms R&D-Institutions	Government R&D-Institutions Firms
Drivers for innovation	Networking between specialize firms	Co-operation between different actors	R&D-Institutions
Premise makers	Firms **NCE Subsea**	Firms, R&D-Institutions Government	R&D-Institutions
Premise takers	R&D-Institutions		Firms
Strategy	Specialisation (Co-operation between different pa within the same indust	Diversification (Benefit from actors within different industries)	Variation (New role for academic institutions)
Facilitators	Cluster F litators	Intermediate actors	Government/Academia Intermediate actors
Scale	From local to global. (Moving towards global will require a strong R&D-component where the R&D-Institutions are premise makers and drivers for innovation)	From regional to national	From regional to global

Table 6 - NCE Subsea in the current model for co-operation

In Table 6 – NCE Subsea has been positioned in the cluster model for co-operation between SMEs and R&D. The table also shows the potential for upgrading NCE Subsea to be a GKH. For NCE Subsea to both increase the level of sustainable innovation in co-operation between SMEs and R&D-Institutions and develop into a GKH, it can be beneficial to evaluate elements from other models for Industry/R&D co-operation. One of the elements I would argue is beneficial to NCE Subsea is to facilitate for R&D-Institutions as premise makers rather than the SMEs. This can be seen in both the RIS-Model and TH-Model. If NCE Subsea is to be able to increase the level of sustainable and disruptive innovation then the R&D-Institutions must be positioned as the premise makers for this to happen.

Summary

Considering NCE Subsea's positioning and objectives to expand globally there will probably not be a clear cut between the models. The current situation states that co-operation within the cluster should follow the cluster model. However the desired situation is expanded co-operation between SMEs and R&D-Institutions that leads to increased sustainable innovation. For NCE Subsea to

reach that level of innovation, some changes are required with respect to where the premises for innovation is set. Disruptive innovations should be according to the R&D-Institution's premises as these might be better positioned for long term look ahead on trends and market needs. How NCE Subsea can achieve this is discussed in the GAP analysis presented later in this section.

For NCE Subsea's development towards a GKH, the increase in sustainable innovation and focus on the R&D-Institutions will play an important role. Reve and Sasson (2012) argue that a GKH needs to have a high degree of Research and Innovation attractiveness. For NCE Subsea to improve this attractiveness, the R&D-Institutions need to be the drivers and premise makers for innovation.

Research question 2 - What are the main challenges for co-operation between SME and R&D in NCE Subsea?

The current situation for Industry-R&D co-operation within NCE Subsea is characterized by some co-operation between the analysed SMEs and R&D-Institutions. This is displayed in the table below.

	WiSub AS	Aadi AS	Amitec AS	Imenco AS
Is currently, or have been co-operating with R&D-institution on innovative projects?	Some co-operation with UiB[7]. But WiSub is mostly the R-partner in co-operation with industry.	Yes, CMR and others	Previously some co-operation with HiB[8]	Some projects with Polytec R&D-Institute
Have received research grants? (i.e. IFU, Petromaks, SkatteFunn)	Yes, Petromax[9]	Yes, NRC, EU	Yes, SkatteFUNN[10]	Yes, IFU[11] but did not complete report and did not receive money in the end.
How does your firm perceive the co-operation with an R&D-Institution?	Not always easy to be a "small" R-partner co-operating with larger Industrial partners.	The co-operation is good. We benefit from it and get new specific products we can commercialize.	The co-operation worked fine, it led to new products we could include in our portfolio.	The co-operation worked fine, it resulted in new good products for our client (Statoil).

Table 7 - Summary current situation from interviews with SMEs

Table 7 shows that three companies, WiSub, Aadi and Imenco currently have co-operation with an R&D-Institution. A fourth company, Amitec have previously had co-operation with HiB, but have no current co-operation. However the interviews also revealed that for Imenco and Amitec, they don't have the resources either to co-operate or apply for funding through public research funds or schemes.

"*We don't perform R&D we do not have the time it takes to perform the radical innovations. We concentrate on new products and product improvements within the already established product line. We do all these small step innovations in-house and have a good relationship to Polytec R&D if we need more knowledge.*"

Imenco

[7] University of Bergen (Norwegian: Universitetet i Bergen)
[8] Bergen University College (Norwegian: Høgskolen i Bergen)
[9] Research fund managed by Norwegian Research Council (NRC)
[10] SkatteFUNN is a scheme to incentivise R&D, managed by NRC
[11] Industrial Research and Development Contracts (Industrielle Forsknings og Utviklingskontrakter) Innovation Norway

"*We have previously tried to apply for the SkatteFUNN scheme, but we don't have the resources it takes to complete an application or the required report after the project is finished. We question the benefit from this scheme as it takes more time to fill in all the paperwork than what we feel we get back from it. For other schemes we haven't even considered as they seem to require even more paperwork than SkatteFUNN.*"

Amitec

This shows that lack of resources inhibits both co-operation and the effort to apply for funding from different schemes. The lack of resources seems to be a recurring problem for the SMEs. When Aadi was asked if they have a dedicated group of people who apply for funding the answer was:

"*No, I wish we could do that, but we're not big enough to have a dedicated department for this. But we have some project managers who are trained and experienced to take care of the applications.*"

Aadi

	Uni	**CMR**
Is currently, or have been co-operating with SMEs on innovative projects?	Some good preliminary projects funded by NCE Subsea. But difficult to take it to the next step with SME due to lack of funding	Many preliminary projects with support from NCE Subsea. Many have led to industrial projects. Can be difficult to continue if the industrial project requires large capital to conduct.

Table 8 - Summary current situation from R&D-Institutions

Table 8 shows that the R&D-Institutions list the same challenge when co-operating with SMEs. The preliminary projects are fully funded and both Uni and CMR have good experiences from these projects. The challenge is explained as when the good projects are taken forward to an industrial project for commercialization, it can be difficult to fund the next step due to lack of capital in the smaller companies.

A major challenge and hindrance to co-operation between SMEs and R&D-Institutions seem to be related to resources. Both human and economic resources are limited and both are required in a co-operation. The processes for funding applications might be too comprehensive for a smaller firm to handle without support from, for example, the facilitators in NCE Subsea. In addition the firms experience a high volume of orders due to a very high activity level in the subsea industry.

This level has been high for a long time and it seems likely to continue stay high and even increase in the future. This is perhaps one of the reasons why SMEs don't prioritize co-operation with R&D-Institutions. For the current situation, they simply don't need disruptive innovations to maintain sustainability. It seems that the high level of activity ensures sustainability for small-step innovations and hence the SMEs don't have to prioritize co-operation with the R&D-Institutions.

Summary

It is clear there are major challenges for co-operation between SMEs and R&D-Institutions in NCE Subsea. One of the main challenges related to lack of resources.

However the lack of resources can also be seen in conjunction with a situation where SMEs don't apparently seem to need disruptive innovations to maintain sustainability. There is an overall shortage of engineers in the Norwegian offshore industry, which in general leads to some firms having a specific need for labour to be able to deliver according to their orders. Other firms might be impeded to grow due to the lack of resources which means that the firm is able to deliver current orders, but have to reject enquiries that could lead to increased turnover. As this high level of activity seems likely to be sustained and even increase, it is reasonable that the firms prioritize their limited resources to the need of their customers rather than to co-operate with R&D-Institutions.

However, both Asheim and Isaksen (1997) and Fagerberg et al. (2005) argue that disruptive innovations are required to maintain long term sustainability which should be taken into consideration in strategic decisions. Small-step innovations might be sustainable in the short term but to maintain sustainability in the long term, disruptive innovations are required and this is where the R&D-Institutions can contribute with knowledge and expertise.

There are several sources for funding applicable to the SMEs in NCE Subsea. However, the norm is that all projects require some co-operation with an R&D-partner. The challenge here seems to be comprehensive documentation and administration both in the application process and in the reporting phase. The outcome of the report phase will normally release the funding which means that it is necessary to ensure good quality on the reports which is very resource demanding. From the investigated cases, some manage to be approved for funding, but the others have decided not to use their resources as it seems that the work required is not proportionate to the funds released.

This seems to be the situation for some of the SMEs and NCE Subsea could facilitate for improvement here by assisting the SMEs in both the application and report processes.

Research question 3 - How can the relationship between SMEs and R&D-Institutions be improved? GAP analysis

Different models for Industry/R&D co-operation have been identified and the model that fits the current situation in NCE Subsea is argued to be the cluster model. However, there are elements in the other models for co-operation that can be utilized in order to improve the situation. There are several measures that can be taken in order to improve the relationship between SMEs and R&D-Institutions in NCE Subsea. The data collection identifies four key measures that I will discuss.

1) Facilitate arenas where both SMEs and R&D-Institutions can meet

In chapter 2.3 I discussed possible reasons for why co-operation is not optimum. I find it reasonable to believe that this might be because the different groups within the cluster are unfamiliar with each other. It might be possible that there is a tacit politeness from the interviewed parties that has led to some information being withheld. However, I find it reasonable to discount that the reason is due to difference in knowledge bases as I have shown that both the industrial examples studied, and the R&D examples studied, to a large extent have an analytic knowledge base among their employees

This illustrates that the root cause is that the different groups to some extent are simply unfamiliar with each other. The best way forward to improve this situation would be to establish arenas where these groups can meet. During the interviews, all respondents were asked for input on the establishment of ‘Speciality networks’ where the industry and R&D-institutions have common interest. All respondents were positive to this and some of the respondents even informed that they could participate in the establishment of such networks.

The first measure for NCE Subsea to cover this gap therefore is to facilitate arenas where industrial partners and R&D-institutions can meet, preferably in the form of Speciality networks.

“*We need the industry to visit us, to familiarize and inform what we can do*”.

Uni

"*We need to meet; there is something about these meeting places. I think that is what's needed that we just think about each other when we have something that can be used. And I think these meeting places can be the start of many projects*".

Aadi

"*We know each other and the people. The personal relationships are very good. This is an important factor in why the co-operation with Polytec (R&D-Institution) has been good*".

Imenco

2) NCE Subsea facilitates introduction to different programs for government funding

There are many different sources for government funding that applies to SMEs in NCE Subsea. A rule of thumb for the different funds is the requirement of co-operation between industrial partners and R&D partners. NCE Subsea acknowledges the potential benefit for both SMEs and R&D and has for the last few years worked on recommendations, guidelines and support to its members in the application process for government funding. However, the interviews revealed that some of the SMEs still claim that they don't have the resources to apply and follow up applications for such funding. I find it reasonable to believe that there are several reasons for this.

- The recommendations, guidelines and support from NCE Subsea might not be known to all SMEs
- The SMEs in particular have limited resources and might need extra support in order to familiarize with the different application processes
- The required paperwork seems to be so comprehensive that the benefit is less than the effort that's put into it.

My recommendation is that NCE Subsea continues the work on recommendations, guidelines and support related to different government funding processes with a specific focus on the SMEs. I find it reasonable to believe that this in turn will encourage more SMEs to benefit from co-operation with R&D-Institutions with the potential bonus of different sources of funding. A suggested measure is to plan and conduct workshops both on application processes and requirements for reporting during the project.

3) The R&D-Partners organize as an R&D-Hub

Following the introduction of more and more sophisticated 'Information-Communication-Technology' (ICT) solutions combined with cost saving initiatives, a new way of organizing R&D in 'Multi National Corporates' (MNC) emerged in the late 1980s and throughout the 1990s. International R&D co-operation was established in order to utilize different locations' knowledge, experience and close proximity to external specialized organizations such as Stanford University in the US for ICT and Bangalore in India for software development. Gassmann and von Zedtwitz (1999) conducted research on several MNCs and found that these corporations changed the way they performed their R&D activities during the 1990s. The 'R&D hub model', is described as having tight central control which "reduces the risk of suboptimal resource allocation and R&D duplication" (Gassmann and von Zedtwitz, 1999, p. 241).

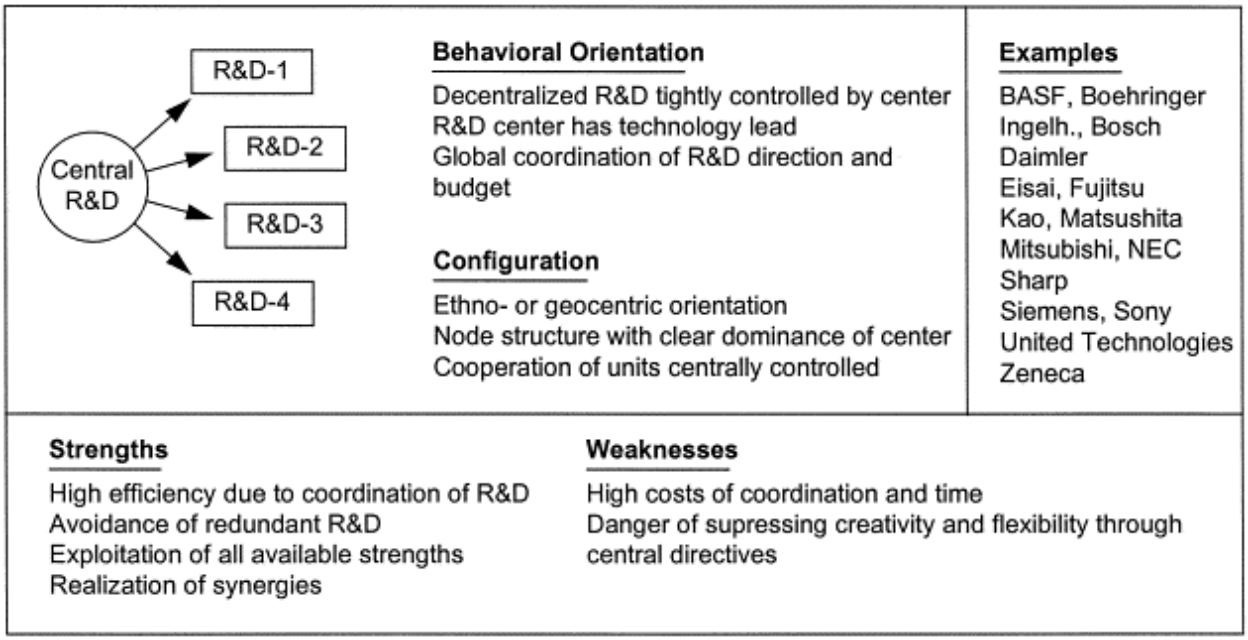

Figure 7 - The R&D hub model (Gassmann and von Zedtwitz, 1999, p. 241)

Figure 7 illustrates the R&D hub model's central R&D and 4 different R&D locations. The strengths of utilizing resources and realize synergies match with the intent of reducing cost. However, there are weaknesses that need to be addressed for full optimization. In addition, Gassmann and von Zedtwitz (1999) argue that an R&D hub model will guarantee efficient

technology transfer, permanent assistance and may be formed as a legal entity where 'Intellectual Property Rights' (IPR) are handled.

NCE Subsea has eight affiliated R&D-partners and it seems reasonable to assume that both the R&D-partners and other affiliates of NCE Subsea can benefit from a R&D-Hub. I also find it reasonable to argue that a dynamic R&D-environment within NCE Subsea will increase the level of disruptive innovations. Joined forces among the R&D-partners will create a much more powerful environment for R&D which will also improve NCE Subsea's position in the process of becoming a Global Knowledge Hub (GKH). An important aspect when positioning to become a GKH is a strong R&D-environment and it is reasonable to believe that a R&D-Hub will better position NCE Subsea in the work towards becoming a GKH.

4) Facilitate for the R&D-Institutions to act as premise makers for co-operation

The summary of models for Industry/R&D co-operation in chapter 2.2, identifies one of the differences between the three models to be who acts as premise maker for co-operation. If NCE Subsea wants to improve the degree of sustainable innovation it is important to facilitate for the R&D-Institutions to be premise makers. Achieving this might lead to a new direction of disruptive innovation within NCE Subsea which would take place on a higher level. This might avoid situations where it would be problematic for an industry to participate due to the fact that the competition might be in the same project. This would also address the challenge in respect of the different time focuses between Industry and R&D as discussed in chapter 2.3. If the co-operation is not driven by a specific industry need, but rather a general trend within the industry, it is reasonable to believe that the industry could afford to spend adequate time for the research project to be a success.

Elements from the RIS model can prove useful when taking Industry/R&D co-operation to the next level. As discussed in section 2.2, the RIS model is not industry specific but utilizes several industries within a geographic region. A RIS model for co-operation in NCE Subsea could include industrial partners and R&D-Institutions that don't operate within the Subsea industry. It is reasonable to believe that these external partners could add value to co-operation for all parties.

Summary

The four listed measures to improve the co-operation for SMEs and R&D-Institutions will require different levels of resources. Measure 1 (Facilitate arenas where both SMEs and R&D-Institutions can meet) and measure 2 (NCE Subsea facilitates introduction to different programs for government funding) can be implemented relatively fast with a little level of resources. In fact, measure 2 is already an on-going project but it might not be well enough known to the SMEs.

Measure 3 (The R&D-Partners organize as an R&D-Hub) and measure 4 (Facilitate for the R&D-Institutions to act as premise makers for co-operation) will require both strategic decisions and a shared understanding within NCE Subsea that these measures are the right way to go. NCE Subsea must communicate this to the members and also implement the changes with the objectives that this is beneficial for the entire cluster and that the affiliates should adapt to the new models.

However, it is perfectly possible for the SMEs to conduct both small-step and disruptive innovations in NCE Subsea. The SMEs should continue to serve their customers with new and better products even if they are small-step innovations, but at the same time the SMEs should be encouraged to participate in joint R&D-projects with both affiliated firms and R&D-Institutions in NCE Subsea. I find it reasonable to argue that this will lead to better co-operation which in turn will lead to more sustainable innovations.

Research question 4 - How can NCE Subsea avoid negative effects of path-dependency?

From the history of NCE Subsea and the selected cases I've found that the majority have been operating within the subsea industry for several years. Examination of different models for co-operation between industry and R&D-Institutions, as discussed in this thesis, shows that there is a potential for negative effects from path-dependency.

Path dependency and path development were discussed in section 2.1. Martin and Sunley (2006), explain path dependence where a process or system is unable to unleash from its history. It is therefore both necessary and important for NCE Subsea to consider different methods for Industry/R&D co-operation in order to avoid the negative effects of path-dependence and also to continue to further develop the cluster.

The research I've conducted does indicate that NCE Subsea in particular is at risk of the negative effects of path dependency, but this is an important issue that needs to be addressed to minimize the risk of a lock-in situation.

Martin (2010) argues that emerging new industries are able to unleash from history, especially where they have a high level of competency, skills and experience. I would argue that there is a high possibility that this is possible for the SMEs and R&D-Institutions within NCE Subsea as there is a relatively high educational level among the employees. If NCE Subsea succeeds in the process of improving the model for Industry/R&D co-operation and implement Complex Combined Innovation (CCI), I assume that there is a high possibility to see the path developing into a dynamic process which expands the possibilities for a further development of NCE Subsea. CCI is argued by Isaksen and Karlsen (2012b) to be a good measure to prevent negative effects of path dependency.

Summary

There are no indications from the studied cases that NCE Subsea is at risk for the negative effects of path dependency. However, it is important for NCE Subsea to be aware of the potential risk of a lock-in situation. Both SMEs and R&D-Institutions have a relatively high educational level in their employees which will increase the possibility to develop a more economically viable path with changes. The high level of competence, combined with CCI will be good preventative

reasons for negative effects of path dependency. I therefore find it reasonable to say that there is a high possibility for this change in models to occur and that new processes can lead to expanded possibilities for the development of NCE Subsea.

4.2 Summary Analysis and Discussion

During the analysis and discussion I have identified the current and desired situation. This is summarized in Table 9.

Research question	Current situation	Desired situation
Which model for SME-R&D co-operation is prominent in NCE Subsea?	Cluster model	Facilitation for both SMEs and R&D-Institutions being premise makers
What are the main challenges for co-operation between SME and R&D in NCE Subsea?	Lack of personal and economic resources. The SMEs prioritize resources on orders rather than R&D	Industry/R&D co-operation on both part's premises SMEs prioritize resources to co-operate and apply for relevant funding
How can the relationship between SMEs and R&D-Institutions be improved?	Some SMEs and R&D-Institutions have a relationship	A better relationship between more SMEs and R&D-Institutions
How can NCE Subsea avoid the negative effects of path-dependency?	NCE and members have a long history of an industry driven cluster which have a potential to negative effects of path-dependency.	Utilize the competency and experience from the members and partners to get a more economically viable path-development

Table 9 - Current and desired situation

During the interviews it is my perception that both SMEs and R&D-Institutions are positive to co-operation but that there are some challenges that need to be overcome and some changes that need to be made. This has been discussed and argued for along with a set of measures that, if implemented, might improve the current situation.

I find it likely that the SMEs will continue to conduct small-step innovations where the industry is the premise maker for such innovation. However, I have argued for the need to also conduct disruptive innovations that can be carried out in co-operation with the R&D-Institutions. For the disruptive innovations it is important that the R&D-Institutions are premise makers. This will also be beneficial for NCE Subsea to position itself as a GKH. One step towards this is to establish an R&D-Hub and introduce elements from other models for industry/R&D co-operation to the

established industrial cluster model. In this way, the R&D-Institutions can take a position as premise makers for disruptive innovations within the cluster at the same time as the SMEs continue to be premise makers for small-step innovations driven by their customer's needs. This will bring "the best from two worlds" to NCE Subsea and it seems reasonable to assume that this will contribute to maintain sustainable activities for all involved parties within NCE Subsea.

I have argued for why the R&D-Institutions should be premise makers for disruptive innovations within NCE Subsea but the industry needs to be actively present in research and development. The SMEs possess valuable knowledge and experience that can complement the R&D-Institution's knowledge. In order to avoid situations where either the SMEs or the R&D-Institutions find it difficult to co-operate due to issues with IPR or confidential competitor information, the disruptive innovation projects should be increased to a higher level where the projects concentrate on system change rather than specific product changes. The R&D-Institutions should be able to create longer forecasts that anticipate long term trends and needs for the industry. Innovations at this level will involve questions related to IPR, but most likely avoid aspects that involve confidential information that can be difficult for competitive SMEs in an R&D-project.

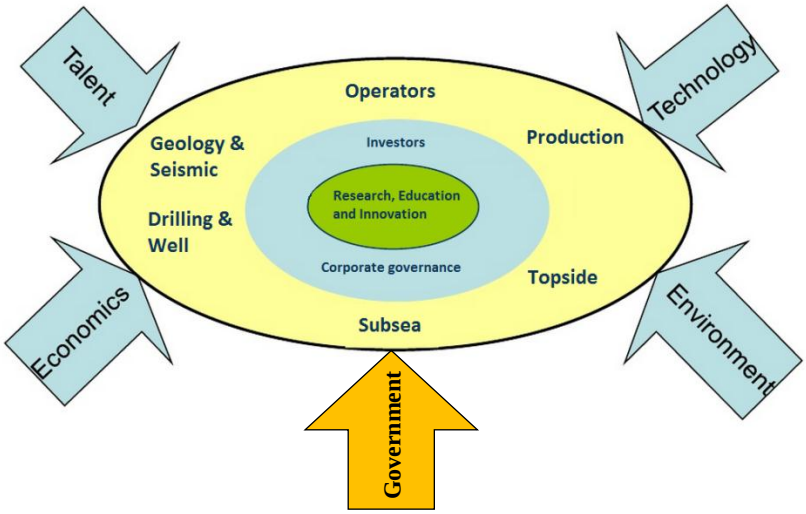

Figure 8 - The Norwegian Off-shore Industry as a Global Knowledge Hub (Reve and Sasson, 2012)

The Global Knowledge Hub of the Norwegian Off-shore Industry was discussed in Chapter 2.2 and has throughout this thesis been used as a model for NCE Subsea as a GKH. The subsea industry is a part of the Norwegian Off-shore Industry and it is therefore reasonable to assume

that many of the conditions applicable to the Norwegian Off-shore Industry are applicable to NCE Subsea.

There is, however, one external factor that I believe could be added to the model. That is the Government which base legislation on political decisions. There is a large potential for undiscovered oil and gas fields both in Norway and other locations. However, even though exploration and development of new fields on paper might seem economically viable, there can be many political reasons for legislations that prevent both exploration and development in these areas. The reasons can be environmentally, economically, technically; or justified by our responsibility to hand over the world to coming generations in a condition at least as good as we received it. The Norwegian Government will be premise makers for Health, Safety and Environmental (HSE) standards, taxation, announcements and awarding acreage and requirements for infrastructure. The off-shore industry is premise takers and changes in these premises might affect the industry.

I find it reasonable to identify this external factor as important to both the Norwegian Off-shore Industry and NCE Subsea as both groups are depending on the Off-shore industry to maintain the activity. There are on-going discussions in Norway as to whether the government should either open new areas for development or keep them protected based on the above mentioned reasons. This thesis has no in-depth analysis of this question but I find it reasonable to say that Government is an external factor that is important to these two GKHs.

Based on the theoretical framework and analysed data, I will argue that there is a large unredeemed potential for sustainable innovations that involves SMEs and R&D-Institutions in NCE Subsea. However, this involves the willingness to change the current situation at NCE Subsea, the industry and R&D-Institutions which will require both personnel and economic resources.

5 Conclusion

Innovative SMEs in NCE Subsea currently base their innovations on small-step innovations (Menon, 2012). Both Fagerberg et al. (2005) and Isaksen and Karlsen (2012b) argue that firms cannot solely base the activities on such incremental innovation but should also focus on disruptive innovations in order to maintain sustainability.

NCE Subsea has several affiliated R&D-Institutions which currently have some co-operation with SMEs in NCE Subsea. However, the current co-operation seems to be on the industry's premise which in turn does not always seem to be the best solution in order to develop sustainable innovations.

This thesis has answered four research questions related to the problem definition.

For research question 1 "Which model for SME-R&D co-operation is prominent in NCE Subsea?" I aimed to critically evaluate co-operation between SMEs and R&D-Institutions in NCE Subsea to identify which model is prominent, how this model is used in NCE Subsea and if there is potential to develop this co-operation to increase the level of sustainable innovation between SMEs and R&D-Institutions.

I have argued that the cluster model is the prominent model for SME-R&D co-operation in NCE Subsea. This conclusion is based on the specialized firms as key actors and premise makers, strategy for specialization and dedicated cluster facilitators. I've also concluded that R&D is a premise taker when co-operating with SMEs in NCE Subsea.

The cluster model enables scaling outside the region. In order to maintain sustainability when scaling to a national or global level, I have argued for required changes which include the R&D-institutions to be premise makers in addition to the SMEs. I have argued that this most likely will improve the degree of sustainable innovations as this will involve the R&D-Institutions at a level where they can better contribute with their expertise.

For research question 2, "What are the main challenges for co-operation between SME and R&D in NCE Subsea?" my objective was to search for challenges with the selected SMEs and R&D-Institutions and critically compare the response to be able to create a best possible picture of the challenges. One of the theories I wanted to test was whether the SMEs perceived the academic level at the R&D-Institutions as difficult, and whether the R&D-Institutions perceived the market orientation at the SMEs as a problem. I did not find anything that could justify this. I've argued that the most probable reason for this is that all the SMEs interviewed to a large extent have employees with an analytic knowledge base, and they might not very different from academic R&D-Institutions.

I've presented the major challenge for co-operation between SMEs and R&D-Institutions to be lack of resources. There is lack of both economic and human resources at some of the SMEs. The SMEs seem to have an advantage of a high activity level and some have made strategic decisions to focus on existing customers rather than co-operation that might lead to new products. With the activity that seems to be sustaining and even increase, it is reasonable that SMEs with limited human resources prioritize existing customers. However, in order to be sustainable the SMEs need disruptive innovations. This can be a difficult choice, especially for the SMEs in NCE Subsea as they have the benefit of a very high level of activity. This high level of activity is likely to remain in the foreseeable future, and this might make it even more difficult. It can seem like the SMEs have such a high level of value creation from small-step innovation that they don't need disruptive innovations. However, according to Fagerberg et al. (2005) and Isaksen and Karlsen (2012b), firms need disrutive innovation in order to maintain sustainability. This is apparantly an imortant aspect the SMEs need to consider.

For research question 3, "How can the relationship between SMEs and R&D-Institutions be improved? ", the objective was to look for potential solutions to how NCE Subsea can utilize the collected information in research questions 1 and 2 to improve the current situation.

First of all I would like to emphasize that there are no findings that indicate a poor relationship between SMEs and R&D-Institutions in NCE Subsea, however there is always room for improvement. Based on the collected and analysed data, I have presented 4 potential measures for NCE Subsea

1. Facilitate arenas where both SMEs and R&D-Institutions can meet
2. NCE Subsea facilitates introduction to different programs for government funding
3. The R&D-Partners organize as an R&D-Hub
4. Facilitate for the R&D-Institutions to act as premise makers for co-operation

I have argued that these four measures can be implemented in NCE Subsea, and it is reasonable to believe that this will improve the co-operation between SMEs and R&D-Institutions. It is further reasonable to believe measure 2, 3 and 4 will apply to all innovative firms in NCE Subsea as these are not limited to SMEs.

I've further argued that measure 1 and 2 can be implemented relatively quickly with limited resources, measure 2 is already an on-going project but it might seem that the SMEs need more or repeated information about the project.

Measure 3 and 4 will require both human and economic resources and will most likely have to be implemented over time as different parts might have different views on both the process and the outcome.

Although I've argued that SMEs need disruptive innovation to maintain sustainability, it is important to emphasize that the SMEs need to continue serving their customers and perform the small-step innovation required. I believe that all technology driven firms in general should have a strategy for sustainable innovation in addition to small-step or incremental innovation. This enables a dynamic that I find reasonable to believe is beneficial to the firms.

For research question 4, "How can NCE Subsea avoid the negative effects of path-dependency?" I wanted to highlight that NCE Subsea potentially can end up in a lock-in situation which is not desirable. From the research there are no indications that a lock-in will occur, but this is important to be aware of.

I have argued that the SMEs and R&D-Institutions in NCE Subsea have employees with a relatively high level of education. This is beneficial in order to avoid these negative effects. NCE Subsea should include members and partners in the development of the cluster and ensure the process is open to all members and partners. Emphasizing Complex Combined Innovation is, according to Isaksen and Karlsen (2012b), likely to lead to a more economically viable path

development. An open process which also facilitates input from members and partners will establish a good basis for the process in order to develop to a more economically viable path.

Limitations and further research

This outcome of this research project is critically considered model for co-operation and challenges for innovation. In addition I have suggested a set of measures which have been evaluated based on the theoretical framework and conducted interviews. However this study only covers a little part of a large system and more research is required to get better answers on the subject.

Potential further research can be if NCE Subsea adopts some or all suggested measures it can lead to new research projects that evaluate these measures. Such evaluation will either validate or discard the measures in order to improve co-operation and sustainable innovation.

The thesis also discusses NCE Subsea's potential and measures towards becoming a Global Knowledge Hub (GKH). Reve and Sasson (2012) have developed a model for evaluating a GKH which can be used as a basis for an evaluation of NCE Subsea. The research could be conducted as a feasibility study for NCE Subsea to become a GKH, or a study on how NCE Subsea performs as a GKH.

Can increased co-operation between SMEs and R&D-Institutions in NCE Subsea improve the degree of sustainable Innovation?

I have now built a base of arguments and answered the 4 research questions which lead to answering the main question, "Can increased co-operation between SMEs and R&D-Institutions in NCE Subsea improve the degree of sustainable Innovation?"
With this argumentation, I will claim the answer is yes. Increased co-operation between SMEs and R&D-Institutions in NCE Subsea can improve the degree of sustainable innovation if the R&D-Institutions are premise makers for innovation. Innovation from such co-operation should be on a system rather than a product level, R&D-Institutions should be premise makers and SMEs and other technology intensive firms in NCE Subsea should contribute with their expertise. I am confident that such co-operation will lead to disruptive sustainable innovation that will be beneficial to NCE Subsea's members, partners and their customers.

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7 Appendix

7.1 Appendix A – SME Interview guide

Norwegian Centres of Expertise
NCE Subsea

HØGSKOLEN I BERGEN

Intervjuguide

Emne: Samarbeid og innovasjon mellom SMB'er og FoU institusjoner

Dette intervjuet er en del av et studium for å kartlegge hvordan graden av innovasjon og samarbeid mellom små og mellomstore bedrifter (SMB'er) og FoU (Forskning og Utviklings) Institusjoner i NCE Subsea. Studiet er et samarbeid mellom NCE Subsea og Høgskolen i Bergen. Bakgrunnen for undersøkelsen er å undersøke hvordan NCE Subsea kan stimulere til økt samarbeid mellom disse to grupperingene for å øke innovasjonsgrad og verdiskapning.

Intervjuene tar sikte på å kartlegge informasjon om samarbeid mellom SMB og FoU-institusjoner og hvordan dette samarbeidet oppfattes. Det tas også sikte på å kartlegge eventuelle årsaker for at graden av slikt samarbeid er lav.

Hovedmålene for studiet er å analysere det samarbeid som finnes idag og årsaker til at samarbeid fungerer. I tillegg ønsker studiet å finne årsaker til hvorfor graden av samarbeid SMB/FoU er lav og gi anbefalinger på hvordan samarbeidet kan bedres.

Samtalen vil ha en varighet på omlag 60 minutter.

Godkjenning:

Informasjonen som blir innhentet vil bli behandlet fortrolig og opplysninger om respondent anonymisert i den videre håndteringen.

Som intervjuet representant for virksomheten godkjenner jeg herved bruk av gitt informasjon på ovennevnte betingelser.

Intervjuet Navn	Intervjuet Signatur
Intervjuer Navn	Intervjuer Signatur
Dato/Sted	

Dette intervjuet er et semi-strukturert intervju, der jeg vil presentere spørsmål, og du er bedt om å svare på disse etter beste evne. Det er viktig å presisere at det ikke finnes rette eller gale svar på denne undersøkelsen. Svar derfor så nøyaktig som mulig i forhold til situasjonen i din bedrift.

Bakgrunnsdata

Virksomhetens navn:	
Virksomhetens besøksadresse:	
Bransje:	
Omsetning 2012 (2011):	
Hvor lenge har virksomheten eksistert:	
Antall ansatte:	
Hva er bedriftens Formål og visjon?	

Arbeider eller har bedriften arbeidet innen andre bransjer enn det som ansees som hovedbransje?

Hvor lenge har du arbeidet i bedriften?

Hva er din stilling/tittel?

Har du tidligere hatt andre stillinger i bedriften?

Kan du fortelle meg kort om din utdannelse og erfaring før du ble ansatt her?

1. Samarbeid

Har bedriften samarbeidet / Samarbeider bedriften på konkrete innovasjonsprosjekter med FoU Institusjoner i eller utenfor NCE Subsea?

Hvis ja:	**Hvis nei:**
Kan du fortelle litt om dette samarbeidet? Hvordan fungerte det? Hva fungerte spesielt godt? Hva fungerte dårlig? Hvordan ble samarbeidet organisert? - Har/hadde bedriften en kontaktperson? - Hvordan ble utgifter fordelt? - Ved eventuelle innovasjoner, var det klargjort på forhånd hvem som var eier eller rettighetshaver? Opplevde du at din bedrift var en likeverdig part i samarbeidet?	Kan du si noe om hvorfor? Er det noen spesielle årsaker eller flaskehalser som gjør at bedriften ikke samarbeider?

Hvilke tiltak kunne du ønske deg for å opprette/utvikle/forbedre samarbeidet mellom dere som bedrift og FoU-miljøer i NCE Subsea

Har bedriften mottatt støtte i form av offentlige midler/tilskudd (eksempelvis gjennom Innovasjon Norge eller Forskningsrådet, Regionalt Forskningsfond eller andre programmer) som skattefunn, IFU, Petromaks eller lignende for utviklings/innovasjonsarbeid? Her ser vi bort fra eventuelt betalte oppdrag fra kunde.

Hvis Ja:	**Hvis Nei:**
Kan du fortelle om hvilken type midler dere mottok og for hvilket utviklingsarbeid dette var? Hvordan foregikk dette? (var det bedriftens egne ansatte som formulerte søknad eller var dette gjort av eksterne personer?) Hvordan er erfaringen med et prosjekt der dere mottar offentlige midler i et nyskapningsprosjekt? Var/er FoU miljøer med som forskningspartner i noen av deres prosjekter?	Er det en spesiell årsak til dette? Er det noen tiltak som kunne vært igangsatt fra f.eks NCE Subsea eller andre institusjoner for at bedriften skal søke offentlige midler til nyskapningstiltak?

Har bedriften noen form for formelt eller uformelt samarbeid som ikke går på konkrete innovasjonsprosjekter med andre bedrifter eller FoU institusjoner i eller utenfor NCE Subsea?

Hvis Ja:	**Hvis Nei:**
Kan du fortelle om dette samarbeidet? Formelt/uformelt? Har det eksistert lenge? Hvordan fungerer det? Hvordan er ressurs og kostnadsfordelingen? Hvordan oppstod samarbeidet?	Er det en spesiell grunn til at dere ikke har samarbeid? - Ikke behov - Ikke ønske - Vil bevare forretningshemmeligheter - Den «rette» samarbeidspartneren finnes ikke.

Ønsker dere mer eller mindre samarbeid?

Ser du på samarbeid som positivt eller negativt for bedriften?

(forretnigshemmeligheter, proprietær informasjon, konkurranse om oppdrag/personell, økt grad av innovasjon, mulighet for å tilby kunden en bedre og mer sammensatt pakke (komplementaritet), utveksling av erfaringer og personell)

2. Kunnskap

Kan du fortelle litt om de ansatte som arbeider med innovasjon/nyskapning/engineering i bedriften?

Hvilken bakgrunn (utdannelse og erfaring) har de?

Ved ansettelse av teknisk personell, hva foretrekker dere?

Nyutdannet ingeniør/siv.ing (0-2 år)

Ingeniør/siv.ing med noe erfaring (2-5 år)

Ingeniør/siv.ing med lang erfaring (5+ år)

Annet (fagarbeidere, teknikere, PhD...)

Kunnskap kan deles inn i to hovedkategorier. Taus og kodifisert.

Kodifisert kunnskap kjennetegnes ved at den er skrevet ned og kan tilegnes ved å lese, delta i en forelesning eller lignende.

Taus kunnskap derimot, kjennetegnes ved at den er vanskelig å skrive ned, og krever øvelse, trening og erfaring for å tilegnes. (Et eksempel kan være å lakkere en bil.)

Alle mennesker besitter både taus og kodifisert kunnskap innen alt fra daglidagse ferdigheter, til fag/yrkesspesifikke ferdigheter. Hvis du skal se på de ansatte i bedriften som arbeider med innovasjon/nyskapning/engineering og deres yrkesspesifikke ferdigheter, er det noen form for kunnskap som er spesiell og viktig for bedriften?

Er dette et konkurransefortrinn?

Har bedriften proprietær kunnskap som er taushetsbelagt?

Hvordan tilegner nyansatte seg denne kunnskapen?

(interne kurs, eksterne kurs, intern opplæring (fadder/trainee), en del kunnskap er forbeholdt spesielle ansatte)

3. Nettverk

Bruker bedriften formelle eller uformelle nettverk som arena for utveksling av erfaringer og kunnskap med tanke på å styrke bedriftens kompetanse?

- Kan du fortelle litt om disse nettverkene? (formelle/uformelle, fagspesifikke/bransjespesifikke, åpen/lukket

Har du deltatt på nettverkssamlinger som frokostmøter/fagdager eller andre arrangement i regi av NCE Subsea der FoU institusjoner også var representert? Kan du evt. fortelle om samtaler/diskusjon med forskere (ansatte i FoU institusjonene)?

Hva tenker du om opprettelse fagspesifikke nettverk i NCE subsea der både industri og FoU-institusjonene er representert?

(hvordan bør det evt. organiseres, hvem skal være initiativtaker, hvem skal drive nettverkene, hvordan vil det være å «bli bedre kjent» med andre likeverdige bedrifter og forskere som arbeider med det samme som deg selv?)

4. Videreutvikling av din bedrift

Hva ser du som det viktigste tiltaket/arbeidet for at din bedrift skal vokse og ha en god verdiskapning?

Ser du noen konkrete hemmere for vekst i umiddelbar fremtid og i et lengre perspektiv?

Har bedriften en langsiktig strategi/visjon som sier noe om hvilke fagområder dere skal arbeide innenfor? (er det tanker om å diversifisere driften innen flere bransjer eller starte opp aktivitet innen andre bransjer?)

5. Avslutning

Har du andre kommentarer til slutt? Er det noe du ønsker å tilføye?

7.2 Appendix B – R&D Interview guide

Norwegian Centres of Expertise
NCE Subsea

HØGSKOLEN I BERGEN

Intervjuguide

Emne: Samarbeid og innovasjon mellom SMBer og FoU institusjoner

Dette intervjuet er en del av et studium for å kartlegge hvordan graden av innovasjon og samarbeid mellom små og mellomstore bedrifter (SMB'er) og FoU (Forskning og Utviklings) Institusjoner i NCE Subsea. Studiet er et samarbeid mellom NCE Subsea og Høgskolen i Bergen. Bakgrunnen for undersøkelsen er å undersøke hvordan NCE Subsea kan stimulere til økt samarbeid mellom disse to grupperingene for å øke innovasjonsgrad og verdiskapning.

Intervjuene tar sikte på å kartlegge informasjon om samarbeid mellom SMB og FoU-institusjoner og hvordan dette samarbeidet oppfattes. Det tas også sikte på å kartlegge eventuelle årsaker for at graden av slikt samarbeid er lav.

Hovedmålene for studiet er å analysere det samarbeid som finnes idag og årsaker til at samarbeid fungerer. I tillegg ønsker studiet å finne årsaker til hvorfor graden av samarbeid SMB/FoU er lav og gi anbefalinger på hvordan samarbeidet kan bedres.

Samtalen vil ha en varighet på omlag 45 minutter.

Godkjenning:

Informasjonen som blir innhentet vil bli behandlet fortrolig og opplysninger om respondent anonymisert i den videre håndteringen.

Som intervjuet representant for virksomheten godkjenner jeg herved bruk av gitt informasjon på ovennevnte betingelser.

_____ _____

Intervjuet Navn Intervjuet Signatur

_____ _____

Intervjuer Navn Intervjuer Signatur

_____

Dato/Sted

Dette intervjuet er et semi-strukturert intervju, der jeg vil presentere spørsmål, og du er bedt om å svare på disse etter beste evne. Det er viktig å presisere at det ikke finnes rette eller gale svar på denne undersøkelsen. Svar derfor så nøyaktig som mulig i forhold til situasjonen i din bedrift.

Bakgrunnsdata

Virksomhetens navn:	
Virksomhetens besøksadresse:	
Omsetning 2012 (2011):	
Hvor lenge har virksomheten eksistert:	
Antall ansatte:	
Hva er virksomhetens Formål og visjon?	

Hvor lenge har du arbeidet i bedriften?

Hva er din stilling/tittel?

Har du tidligere hatt andre stillinger i bedriften?

Kan du fortelle meg kort om din utdannelse og erfaring før du ble ansatt her?

1. Samarbeid

Har virksomheten samarbeidet / Samarbeider virksomheten på konkrete innovasjonsprosjekter med kommersielle bedrifter i eller utenfor NCE Subsea?

Hvis ja:	**Hvis nei:**
Kan du fortelle litt om dette samarbeidet? Hvordan fungerte det? Hva fungerte spesielt godt? Hva fungerte dårlig? Hvordan ble samarbeidet organisert? - Har/hadde dere en kontaktperson? - Hvordan ble utgifter fordelt? - Ved eventuelle innovasjoner, var det klargjort på forhånd hvem som var eier eller rettighetshaver? Opplevde du at din virksomhet var en likeverdig part i samarbeidet?	Kan du si noe om hvorfor? Er det noen spesielle årsaker eller flaskehalser som gjør at dere ikke samarbeider?

Hvilke tiltak kunne du ønske deg for å opprette/utvikle/forbedre samarbeidet mellom dere FoU-miljø og de små og mellomstore bedriftene i NCE Subsea

Har dere hatt samarbeid med SMB'er i NCE Subsea og på bakgrunn av dette mottatt forksningsstøtte (eksempelvis gjennom Innovasjon Norge eller Forskningsrådet, Regionalt Forskningsfond eller andre programmer) som skattefunn, IFU, Petromaks eller lignende?

Hvis Ja:	**Hvis Nei:**
Kan du fortelle om hvilken type midler dere mottok og for hvilket utviklingsarbeid dette var? (Hvis flere, nevn ett/to prosjekt) Hvordan foregikk dette? (var støtten tildelt din virksomhet eller prosjektet, hvem søkte om støtte?)	Er det en spesiell årsak til dette? Er det noen tiltak som kunne vært igangsatt fra f.eks NCE Subsea eller andre institusjoner for at virksomheten skal søke offentlige midler til nyskapningstiltak i samarbeid med de små og mellomstore bedriftene?

Har bedriften noen form for formelt eller uformelt samarbeid som ikke går på konkrete innovasjonsprosjekter med SMB'er eller andre FoU institusjoner i eller utenfor NCE Subsea?

Hvis Ja:	**Hvis Nei:**
Kan du fortelle om dette samarbeidet? Formelt/uformelt? Har det eksistert lenge? Hvordan fungerer det? Hvordan er ressurs og kostnadsfordelingen? Hvordan oppstod samarbeidet?	Er det en spesiell grunn til at dere ikke har samarbeid? - Ikke behov - Ikke ønske - Vil bevare IP - Den «rette» samarbeidspartneren finnes ikke.

Ønsker dere mer eller mindre samarbeid?

Ser du på samarbeid som positivt eller negativt for virksomheten?

(forretnigshemmeligheter, proprietær informasjon, konkurranse om oppdrag/personell, økt grad av innovasjon, mulighet for å tilby kunden en bedre og mer sammensatt pakke (komplementaritet), utveksling av erfaringer og personell)

2. Kunnskap

Kan du fortelle litt om de ansatte som arbeider med innovasjon/nyskapning/forskning ?

Hvilken bakgrunn (utdannelse og erfaring) har de?

Ved ansettelse av personell som skal arbeide med forskning, hvilken utdannelse krever/foretrekker dere?

Har dere stipendiatstillinger?

Kunnskap kan deles inn i to hovedkategorier. Taus og kodifisert.

Kodifisert kunnskap kjennetegnes ved at den er skrevet ned og kan tilegnes ved å lese, delta i en forelesning eller lignende.

Taus kunnskap derimot, kjennetegnes ved at den er vanskelig å skrive ned, og krever øvelse, trening og erfaring for å tilegnes. (mange typer håndtverk krever stor grad av taus kunnskap)

Alle mennesker besitter både taus og kodifisert kunnskap innen alt fra daglidagse ferdigheter, til fag/yrkesspesifikke ferdigheter. Kan du fortelle meg om de ansatte som arbeider med innovasjon/nyskapning/forskning og de ferdigheter de bruker i sin jobb, er det noen form for kunnskap som er spesiell og viktig for virksomheten?

Er dette et fortrinn for din virksomhet?

Har virksomheten proprietær informasjon som er taushetsbelagt?

Hvordan er dette håndtert i forhold til de ansatte som kommer i befatning med denne informasjonen?

Hvordan tilegner nyansatte seg denne kunnskapen?

(interne kurs, eksterne kurs, intern opplæring (fadder/trainee), en del kunnskap er forbeholdt spesielle ansatte)

3. Nettverk

Bruker virksomheten formelle eller uformelle nettverk som arena for utveksling av erfaringer og kunnskap med tanke på å styrke virksomhetens kompetanse?

- Kan du fortelle litt om disse nettverkene? (formelle/uformelle, fagspesifikke/bransjespesifikke, åpen/lukket

Har du deltatt på nettverkssamlinger som frokostmøter/fagdager eller andre arrangement i regi av NCE Subsea der SMBer også var representert? Kan du evt. fortelle om samtaler/diskusjon med ansatte i SMBene?

Hva tenker du om opprettelse fagspesifikke nettverk i NCE subsea der både industri og FoU-institusjonene er representert?

(hvordan bør det evt. organiseres, hvem skal være initiativtaker, hvem skal drive nettverkene, hvordan vil det være å «bli bedre kjent» med andre likeverdige bedrifter og forskere som arbeider med det samme som deg selv?)

4. Videreutvikling av din virksomhet

Hva ser du som det viktigste tiltaket/arbeidet for at din virksomhet skal vokse og ha en god verdiskapning?

Ser du noen konkrete hemmere for vekst i umiddelbar fremtid og i et lengre perspektiv?

5. Avslutning

Har du andre kommentarer til slutt? Er det noe du ønsker å tilføye?